Comparison Of Measured Direct Normal Radiation To Estimates Modeled From Satellite Data

Roberta C. DiPasquale
Donald E. Brown
William S. Chandler
Charles H. Whitlock
Science Applications International Corporation

Robert G. Cable
KJC Operating Company

Paul W. Stackhouse, Jr.
NASA Langley Research Center

DATA SOURCES

International Satellite Cloud Climatology Project (ISCCP)

- VIS/IR radiance and cloud data set
- Global coverage by multiple satellites, 3-hourly measurements
- 10-year average 1983-1993, 1986, 1992
- SSE Project
  - ISCCP D1 interpolated 2.5^{o} equal-area to 1^{o} equal angle
- GEWEX/SRB Project
  - Modified 1^{o} equal-angle derived from ISCCP DX

TMY Direct Normal Radiation (DNR)

- 56 primary stations, over 90% of the radiation data is modeled
- January – measured DNR at Seattle, Washington
- July – DNR is modeled

Hourly DNR measurements at Kramer Junction, CA

- 1992
- 10 year average, 1989 – 1999

METHODS OF COMPUTATION

Pinker/Laszlo Physical Shortwave Model

• Uses satellite data and delta-Eddington two-stream radiative transfer approximation to compute global horizontal and diffuse irradiance

Perez Conversion Model

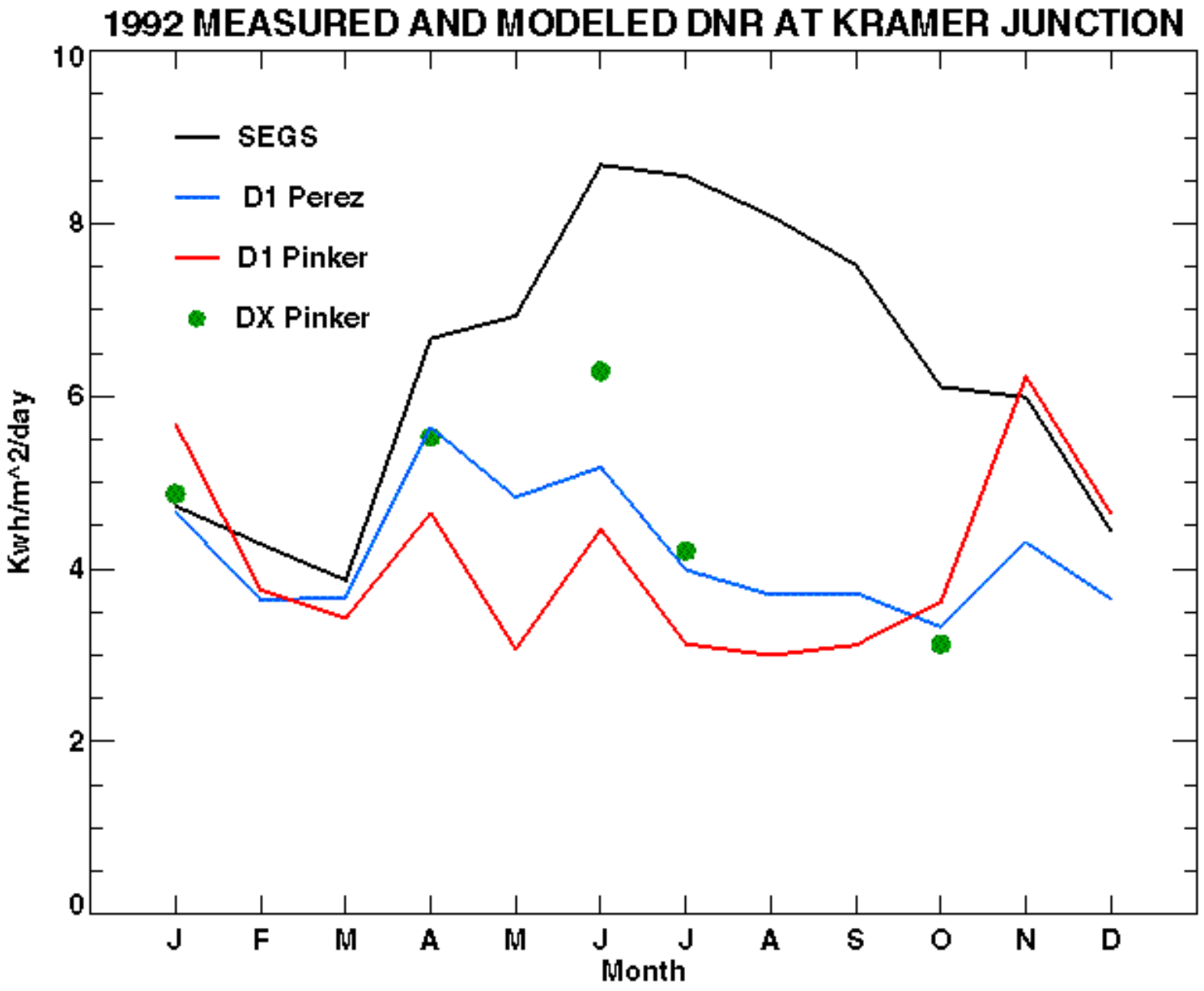
• Linear equations derived statistically from multi-climatic ground measurements
• Hourly input: global horizontal irradiance, solar zenith angle, Julian day, elevation

Input Computations for Perez Model

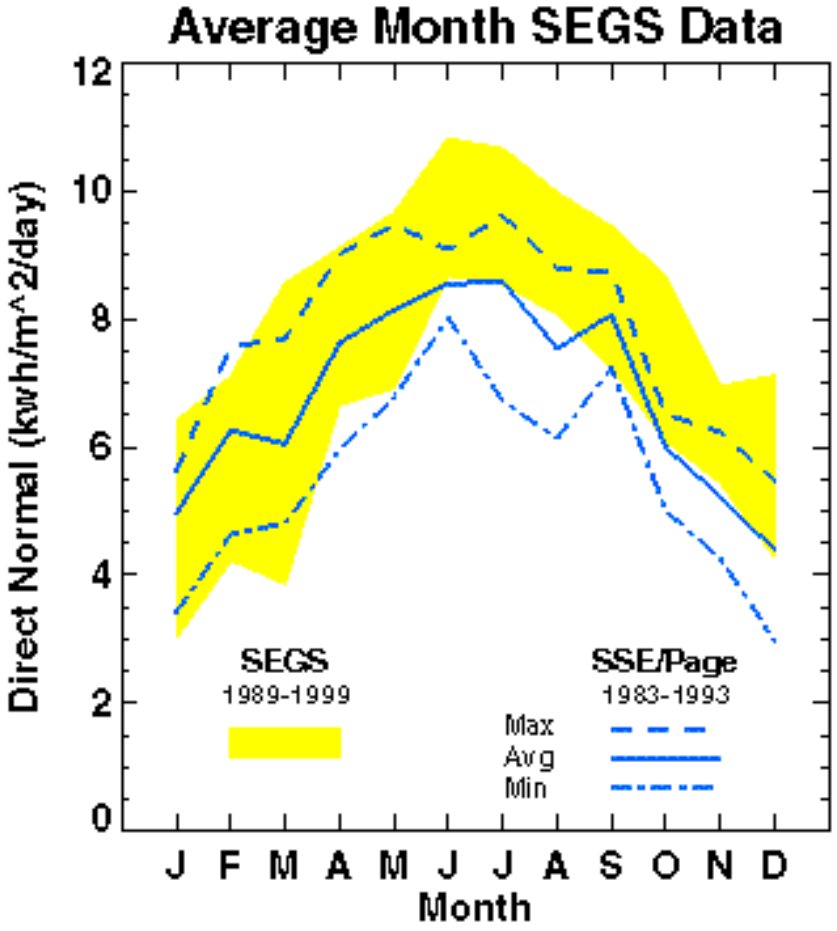
• Linearly interpolated 3-hourly Pinker/Laszlo global horizontal irradiance
• Analyzed cloud fraction data – irradiance values prior to and following solar noon were extrapolated to solar noon if cloud cover was < 20%
• Hourly solar zenith angle calculations

Page Model

• Performs clearness index variance comparisons on ground measurement reference stations to compute diffuse irradiance
• Monthly global horizontal irradiance for a 12 month period is required


1992 MEASURED AND MODELED DNR AT KRAMER JUNCTION
SEGS
D1 Perez
D1 Pinker
DX Pinker
Kwh/m^2/day
10
8
6
4
2
0
J
F
M
A
M
J
J
A
S
O
N
D
Month

SEGS DATA COMPARED TO RELEASE 3 SSE/PAGE



El Nino/La Nina Events

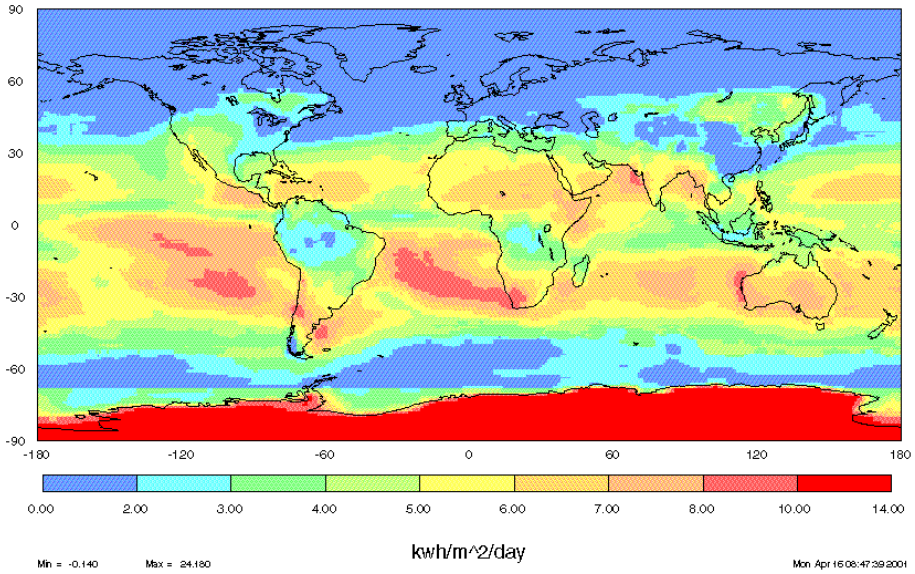
	SEGS 1989-1999	SSE/PAGE 1983 -1993
NO EVENTS	2	5
EL NINO (AVERAGE)	3	3
EL NINO (STRONG)	1 (2 Yr)	0
LA NINA	3	2

→ SEGS AND SSE/PAGE (13 SITES) ARE WITHIN 16%
YEAR-TO-YEAR VARIABILITY SIMILAR (+/- 15%)

GLOBAL ESTIMATES OF DNR USING THE PAGE MODEL
10 Year Average, 1983-1993

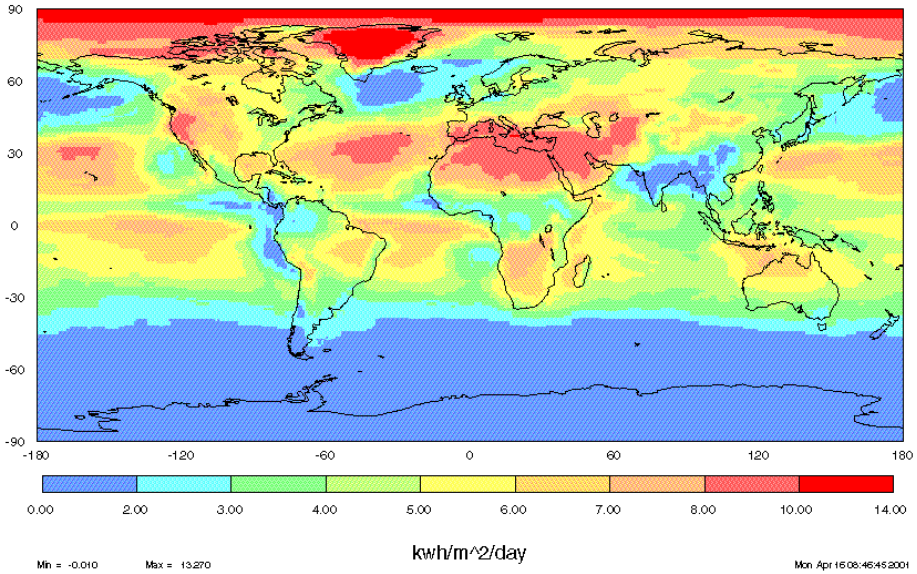
Direct Normal

January, (Page Method, 13 Reference Sites)



Direct Normal

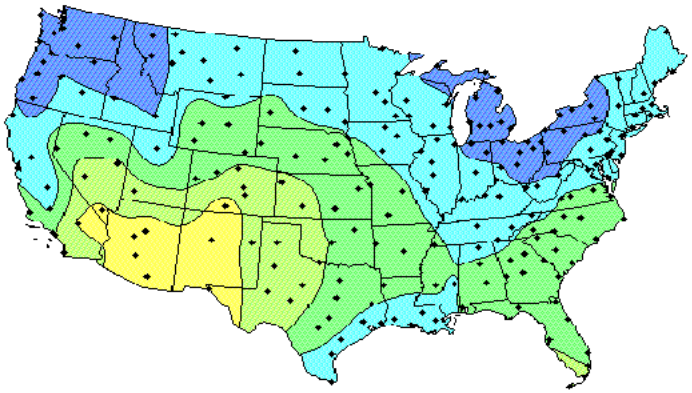
July, (Page Method, 13 Reference Sites)



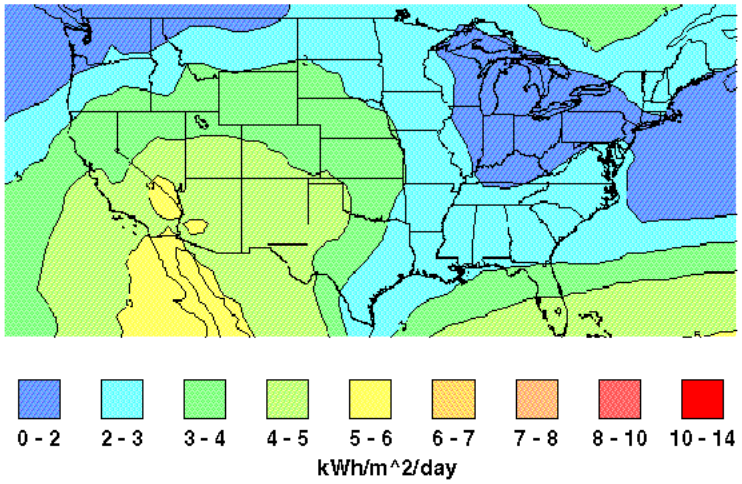
COMPARISON OF DIRECT NORMAL RADIATION

January

TMY Data

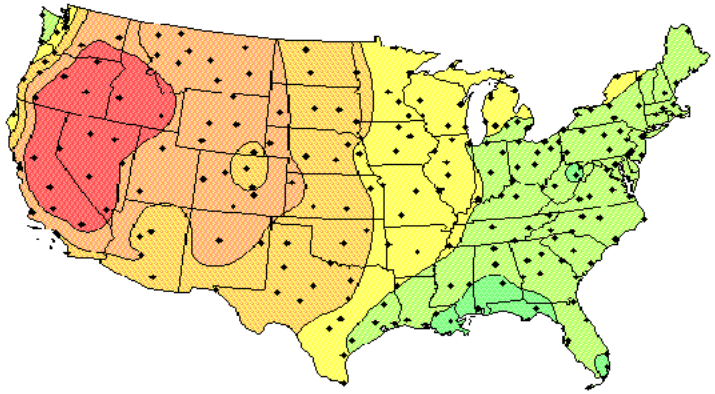


Release 3 SSE/Page (13 sites)



July

TMY Data



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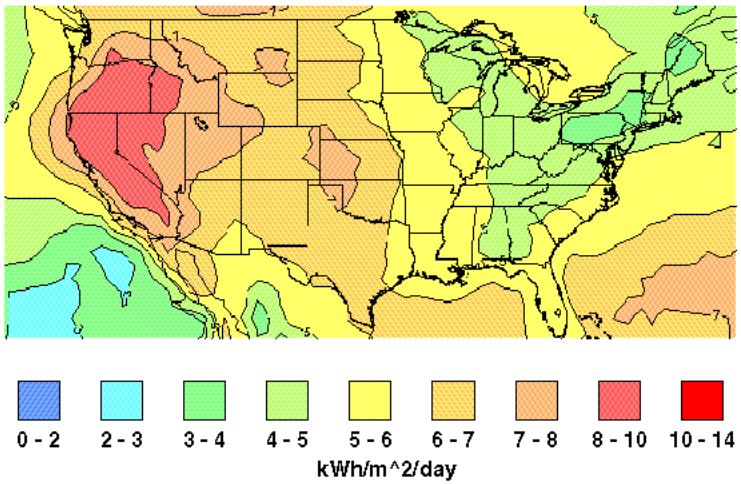

COMPARISON OF DIRECT NORMAL RADIATION

January

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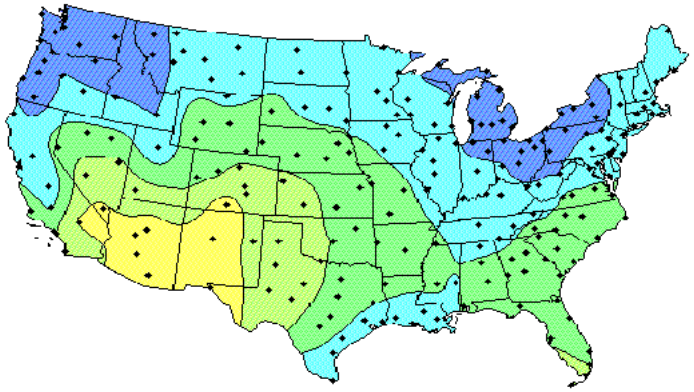
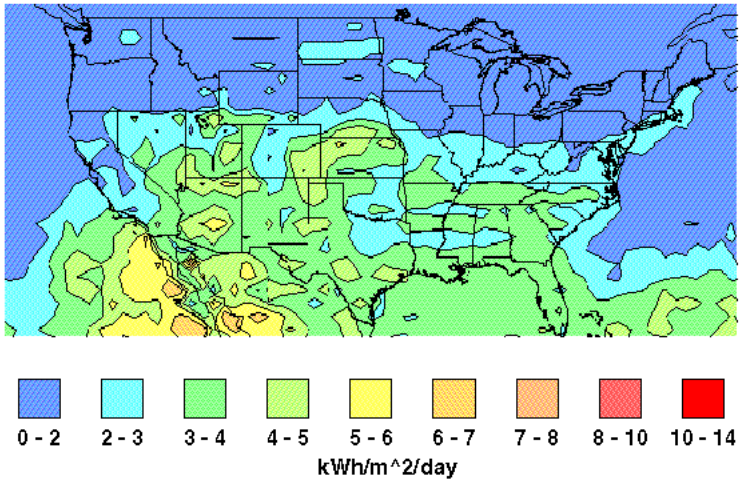
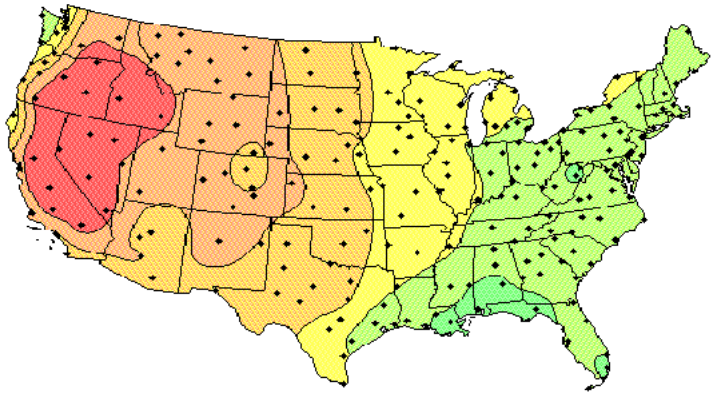


Pinker/Laszlo DX, 1986

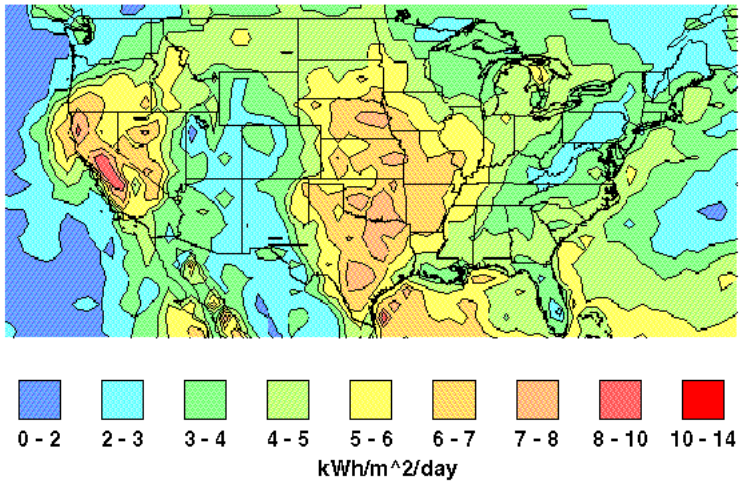


July

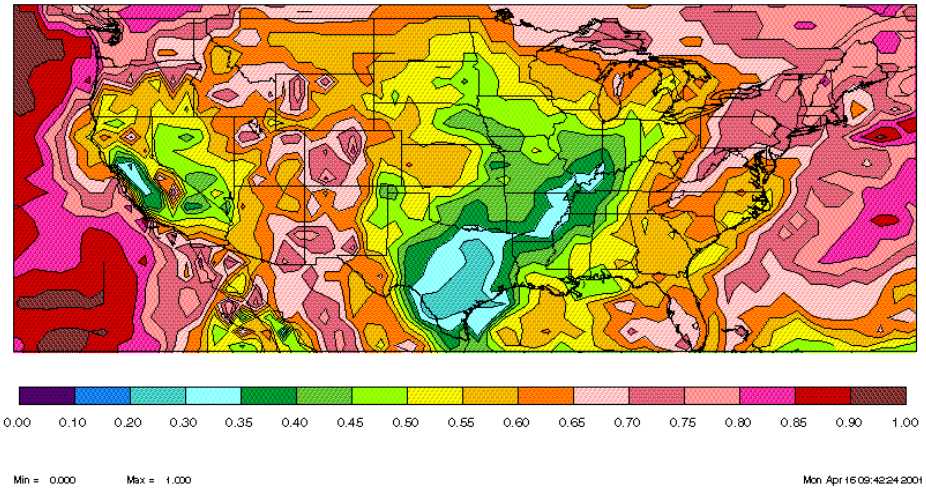
TMY Data



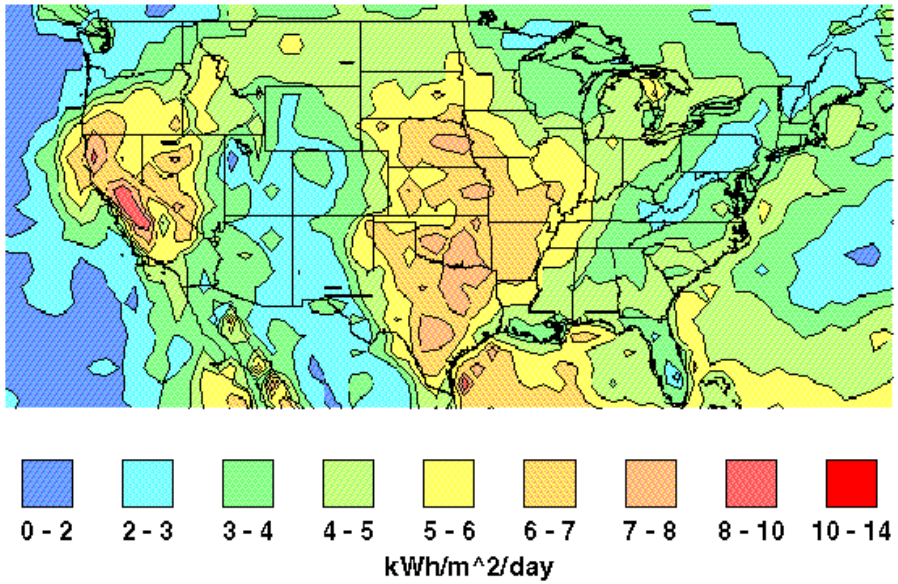
Pinker/Laszlo DX, 1986



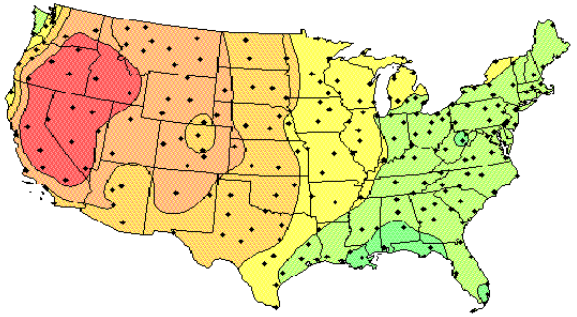
ISCCP DX Cloud Fraction, July 1986



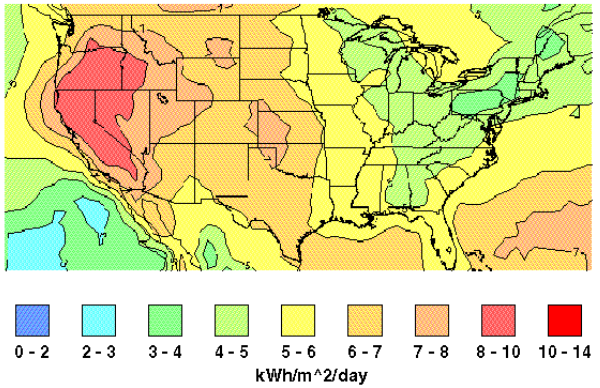
Pinker/Laszlo DNR, July 1986



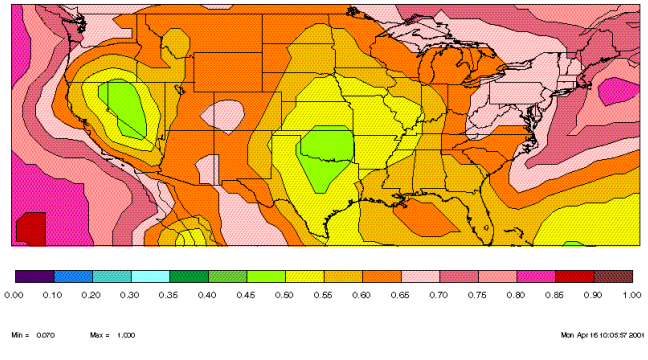
July
TMY Data



Release 3 SSE/Page (13 sites)



SSE Cloud Fraction
July



CONCLUDING REMARKS

Capability to process DNR on a global scale

- SSE Project
  - ISCCP D1 interpolated 2.5^{o} equal-area to 1^{o} equal angle
- GEWEX/SRB Project
  - Modified 1^{o} equal-angle derived from ISCCP DX
- 10-year time frame: 1983 – 1993

Investigating methods for determining DNR

- Page
- Pinker/Laszlo
- Perez (using Pinker/Laszlo global horizontal irradiance)

Current Issues for Continuing Work

- Limited measurement data available for validating DNR
- Comparison to DNR measurements complicated by space/time sampling issues between grid box average and point measurement
- Aerosol optical properties and distribution (clearness index)